4 Mathemat. vol. 3.

A

# NEW AND EASY METHOD

## OF FINDING THE

# LONGITUDE

## AT

# SEA,

WITH

Like ACCURACY that the LATITUDE is found.

Adapted to GENERAL USE,

By T. KEAN. K

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THE

# PREFACE.

THE author preſents the public with the following ſheets, containing a new and eaſy method of finding the longitude at ſea, by the moon's true central altitude; adapted to general uſe, with very little more trouble than the method by which the latitude is found, and with the like accuracy.

The

The Tables (except one) are not more in number, than thofe made ufe of in taking an altitude of the fun; the operations rendered clear and eafy, being fuch as mariners, in general, make ufe of in common navigation.

The Examples are calculated for north and fouth latitudes; for eaft and weft diftances; for morning, noon, and evening altitudes; for the moon's rifing and falling; and all the variety of circumftances that may happen in the courfe of a long voyage, at any time of the year, or in any part of the world.

As the moon is perceptible about twenty-four days in each month, the mariner will have opportunities fufficient to make his obfervations in *day-time*; without a precarious dependence on the *night*, or a reliance on (perhaps) un-

unſkilful aſſiſtants, and ten or twelve tedious additional tables.

The Calculations made by the altitude of the moon's upper limb on the body of the ſun, off George's Iſland in the South Sea (as in the ſeventh Example), will verify the eaſe and accuracy of this method at all viſible eclipſes of the ſun.

The Illuſtration of the ſeven Examples, after the neceſſary Tables, will ſhew the truth of the altitudes of the moon at the meridians of Greenwich and the ſhip, by giving the ſame latitudes reſpectively, as the altitudes taken by the ſun; and the increaſing or diminiſhing the angle of time at the latter (when the longitude by account is incorrect) will appear very juſt and reaſonable, whether the ſhip be a-head of the reckoning, or the reckoning a-head

head of the ſhip. Upon the whole, he preſumes it will be found to anſwer that purpoſe, for which a general and eaſy method has been ſo long, and ſo much wanted.

A NEW

# A NEW AND EASY METHOD OF FINDING THE LONGITUDE AT SEA.

ADmitting that at the meridian of Greenwich, the Moon comes to that meridian (by the Ephemeris) at a certain hour and minute of the day; and the next day, I find ſhe does not come to the ſame meridian 'till an hour after: conſequently at 90 degrees weſt diſtance, (or 6 hours) ſhe muſt



be

be *(a)* 15 minutes later in coming to their meridian, than at the meridian of Greenwich; at 180 degrees weſt diſtance, ſhe muſt be 30 minutes later; and ſo on, till ſhe has deſcribed her circle; and at 60 minutes difference of time, comes to the place of beginning.

This being granted, I take an altitude of the moon at ſuch time as ſhe riſeth or falleth faſteſt, and moſt equable, admit it to be 10′ (or the 6th part of a degree) in a minute; which ſhews that for 60 minutes, there muſt be 600′ (or 10 degrees) difference of altitude from one day to the other, (or in the ſpace of 24 hours): and that every hour and minute ſhe is altering the ſame, from the time of her departure from the meridian of Greenwich, till her arrival there the next day. For inſtance, at 90 degrees weſt diſtance, ſhe is *(b)* lower by *(c)* 150′ (or 2° 30′) than at the meridian of Greenwich: at 180 degrees weſt diſtance, ſhe is lower by 300′ (or 5° 00′): and ſo on 'till ſhe finiſhes her circle.

*(a)* I have mentioned 15 minutes to avoid fractions, as they are the quarter of 60—(and 60 minutes an hour). But as the moon takes 25 hours (inſtead of 24) to deſcribe her circle, there muſt be a proportionable deduction made from the firſt 15 minutes, and ſo on to the ſecond, &c. In as much as 24 hours are leſs than 25. So that, if the 24th part of 60 minutes be 2 minutes and 30 ſeconds, the 25th part, will be found to be but 2 minutes and 24 ſeconds. Which ſhews that for the firſt 90 degrees (or 6 hours) inſtead of 15 minutes; the true time is but 14 minutes and 24 ſeconds later. Which deduction will conſequently affect the diſtances, and inſtead of 150′ (the firſt diſtance); the true diſtance will be found to be but 144′; and ſo on with all the reſt.

*(b)* Here ſhe is riſing (or to the eaſtward of her time of ſouthing); had ſhe been falling (or to the weſtward of her time of ſouthing) ſhe had been ſo much higher, inſtead of ſo much lower, than at the meridian of Greenwich.

*(c)* See the laſt part of Note *(a)*.

The

### EXAMPLE I.

The 10th day of July 1767, sailing *(d)* west, in the latitude of 47° 15′ south, and west longitude, by account 90° 00′ (or 6 hours in time); I observed at 6 o'clock, apparent time, P. M. the moon's true *(e)* central altitude to be 24° 37′, and that she was rising, equally, at the rate of 10′ in a minute. I found that the same day (by the Ephemeris) the moon passed over the meridian of Greenwich at 11h. 19m. (or 19 minutes after 11 o'clock P. M.); and that the next day she should not come to the same meridian till 12 h. 19 m. So that proportionably by account, she should be 15 minutes later in passing the meridian at the ship, than at Greenwich. But by Note *(a)*, the true time was found to be but 14 minutes and 24 seconds, and the true distance but 144′ (or 2° 24′) west of the meridian of Greenwich.

*(d)* Had it been east, the altitude would have been so much higher than at the meridian of Greenwich, instead of so much lower.

*(e)* By the true central altitude, is meant that altitude, where proper allowances are made for the Moon's parallax in altitude, refraction, dip of the sea, and semi-diameter.

| | | |
|---|---|---|
| At 6 o'clock P. M. moon's lower limb | 23° | 33′ |
| Dip 4′, refraction 2′, deduct | 00 | 06 |
| | 23 | 27 |
| Parallax in alt. 54′, semi-diameter 16′, add | 1 | 10 |
| True central altitude | 24 | 37 |

N. B. Had it been her upper limb, you must have subtracted her semi-diameter, instead of added.

I then (*f*) found that at the meridian of Greenwich, in the same latitude of 47° 15′ south, the moon's true central altitude was (*g*) 27° 01′, which being directly 2° 24′ more than the altitude at the ship, shews that the longitude by account was correct, and the ship not a-head of the reckoning, nor the reckoning a-head of the ship.

And in the like manner do all her intermediate altitudes for every hour and minute, correspond with their respective spaces of time.

(*f*)

| | | h. ′ |
|---|---|---|
| Long 90° 00′ W. | apparent time of obs. by the sun | 6 00 P. M. |
| For 90 00 W. add | | 6 00 |
| | Time at Greenwich | 12 00 P. M. |

Moon's declination at 12h. 00′. P. M. (by the Ephemeris) 25° 05′ S. } Pol. dist. 64° 55′

| | h. ′ ″ |
|---|---|
| Moon's passage at same time | 11 20 36 P. M. |
| True time deduct | 00 14 24 |
| Moon's passage at 6 h. 00′ | 11 06 12 P. M. |
| Time of observation | 6 00 00 P. M. |
| Angle of time | 5 06 12 |

| | | | |
|---|---|---|---|
| 5h. 06′ 12″ converted into degrees and minutes } | 76° 33′ S. | Co. | 9,36660 |
| | 42 45 T. | Co. lat. | 9,96585 |
| | | | 9,33245 |
| | | | 12 08 |
| | | | 52 47 |

| | | |
|---|---|---|
| 12° 08′ S. | Co. ar. | 0,00982 |
| 52 47 S. | Co. | 9,78162 |
| 42 45 S. | Co. lat. | 9,86588 |
| (*g*) 27° 01′ | answering to | 9,65732 |

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## EXAMPLE II.

The 6th day of March 1767, ſailing weſt in the latitnde of $37^{\circ}\ 00'$ north, and weſt longitude, by account $75^{\circ}\ 00'$, at 2 o'clock, *(b)* apparent time, P. M. I obſerved the moon's true central altitude to be $47^{\circ}\ 35'\frac{1}{2}$, and that ſhe was riſing equally, at the rate of $12'$ in a minute. I found that the ſame day the moon paſſed over the meridian of Greenwich at 5h. $11'$ P. M. and that the next day, ſhe ſhould not come to the ſame meridian till 6h. $07'$, which is $56'$ later. So that proportionably, if 6 hours give 14 minutes; 5 hours will give 11 minutes and 40 ſeconds later in paſſing the meridian at the ſhip, than at Greenwich. But by Note *(a)*, the true time was found to be but 11 minutes, and 10 ſeconds, and conſequently the true diſtance but 134.

*(b)* By apparent time, is meant that time ſhewn by the ſun, and is generally found by the ſun's altitude, taken at the diſtance of two hours, or more, from meridian time; and and on the ſame day that you have had a good obſervation of the ſun at noon, ſo that you may know your true latitude, at at the time of taking ſuch an altitude.

I then

I then (*i*) found that at the meridian of Greenwich, in the ſame latitude of 37° 00′ north, the moon's true central altitude was (*k*) 49° 43′½, which being but 128′ (or 2 degrees and 8 minutes) more than the altitude at the ſhip, inſtead of 134 (or 2 degrees and 14 minutes) ſhews that the longitude by account was incorrect, and that the reckoning was a-head of the ſhip 6′, which is equal to 3 degrees and 20 minutes, and conſequently leaves the true longitude at 71° 40′ weſt (inſtead of 75° 00′).

(*i*)

| | | | |
|---|---|---|---|
| | ° ′ | | h. ′ |
| Long | 75 00W. apparent time of obſ. by the Sun | | 2 00 P. M. |
| For | 75 00W. add | | 5 00 |
| | | Time at Greenwich | 7 00 P. M. |

Moon's declination at 7h. 00′ P. M. 26° 16′ N. } Pol. diſt. 63° 44′

| | | |
|---|---|---|
| | h. ′ ″ | |
| Moon's paſſage at ſame time | 5 15 34 | P. M. |
| True time deduct | 0 11 10 | |
| Moon's paſſage at 2h. 00′ P. M. | 5 04 24 | |
| Time of obſervation | 2 00 00 | |
| Angle of time | 3 04 24 | |

| | | | |
|---|---|---|---|
| 3h. 04′ 24″ converted into degrees and minutes } | 46° 06′ | S. Co. | 9,84098 |
| | 53 00 | T. C. lat. | 10,12288 |
| | | | 9,96386 |

42 37

21 07

| | | |
|---|---|---|
| 42 37 | S. Co. ar. | 0,13320 |
| 21 07 | S. Co. | 9,96982 |
| 53 00 | S. Co. lat. | 9,77946 |
| (*k*) 49° 43′½ | anſwering to | 9,88248 |

The

The foregoing examples, in north and south latitudes, being to the west, and made in the afternoon, the following examples are to the eastward of the meridian of Greenwich, and made in the morning.

## EXAMPLE III.

The 10th day of July 1768, sailing east, in the lat. of 46° 52′ north, and east long. by account 75° 00′; at 5 o'clock in the morning, apparent time, I observed the moon's true central altitude to be 45° 24′, and that she was rising, equally, at the rate of 10′ in a minute; I found that she should pass over the meridian of Greenwich at 29 minutes after 8 o'clock the same morning, and that the next morning she should not come to the same meridian 'till 29 minutes after 9 o'clock. So that proportionably by account, if 6 hours give 15 minutes, 5 hours will give but 12 minutes and 30 seconds, earlier in passing the meridian at the ship than at Greenwich. But by Note (*a*), the true time was found to be but (*l*) 12 minutes, and the true distance but 120.

(*l*) If 1500′ (which are the number of minutes contained in 25 hours) give 60 minutes, 1440′ (which are the number of minutes contained in 24 hours) will give 57′ 36″

$$\begin{array}{r} 60 \\ \hline 3456 \\ \hline \end{array}$$

Then, if 24 hours give 3456 seconds, 1 hour will give 144 seconds (or 2′ 24″) which 2′ 24″ being multiplied by 5 h. (the number of hours to the east by account) will give 12′ 00″.

I then

I then (*m*) found that at the meridian of Greenwich, in the ſame latitude of 46° 52′ north, the moon's true central altitude was (*n*) 43° 24′, which being exactly 120′ (or 2 degrees) leſs than the altitude at the ſhip, ſhews that the longitude, by account, was perfectly right.

(*m*)

| | | |
|---|---|---|
| | h. | ′ |
| Long. 75°00′E. app. time of obſ. by the ſun 5h. 00′A.M. of the 10th day, or | 17 | 00 |
| For 75°00′E. deduct | 5 | 00 |
| Time at Greenwich | 12 | 00 P.M. the 9th. |

Moon's decl. at 12h. 00′ P.M. of the 9th day 22° 52′ N. } Pol. Diſt. 67° 08′

| | h. | ′ | ″ |
|---|---|---|---|
| Moon's paſſage at ſame time | 20 | 8 | 38 P.M. |
| True time add | 00 | 12 | 00 |
| Moon's paſ. at 5h. 00′ A.M. of the 10th day | 20 | 20 | 38 P.M. |
| Time of obſ. 5h. 00′ of the 10th day, or | 17 | 00 | 00 |
| Angle of time | 3 | 20 | 38 |

| | | | | |
|---|---|---|---|---|
| 3h. 20′ 38″ converted into deg. and min. | 50° 09½′ | S. Co. | 9,80662 | |
| | 43 08 | T. Co. lat. | 9,97168 | |
| | | | 9,77830 | |
| | | | | 30 58⅓ |
| | | | | 36 09⅔ |

| | | |
|---|---|---|
| 30 58⅓ | S. Co. ar. | 0,06680 |
| 36 09⅔ | S. Co. | 9,90705 |
| 43 08 | S. Co. lat. | 9,86317 |
| (*n*) 43° 24′ answering to | | 9,83702 |

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## EXAMPLE IV.

The 1ſt day of September 1772, ſailing eaſt, in the latitude of (*o*) 20° 48′ ſouth, and eaſt longitude by account, 172° 00′ at (*p*) 28 minutes after 11 o'clock, A. M. apparent time, I obſerved the moon's true central altitude to be 39° 24½′, and that ſhe was riſing, equally, at the rate of 14′ in a minute. I found that ſhe ſhould paſs over the meridian of Greenwich at 28 minutes after 3 o'clock, P. M. (the ſame day), and that ſhe ſhould not come to the ſame meridian till 24 minutes after 4 o'clock, P. M. the next day. So that proportionably by account (the difference being 56 minutes) ſhe ſhould be 26 minutes and 45 ſeconds earlier in paſſing the meridian at the ſhip than at Greenwich. But by Note (*l*), the true time was found to be but 25 minutes and 45 ſeconds, and the true diſtance to be 360½′, or 6° 00½′.

(*o*) When your obſervation of the moon is made in the morning, it is the latitude made at noon of the ſame day, you are to go by; not the latitude made the day before; during which interval, the veſſel ſhould be kept due eaſt, or weſt.

(*p*) A watch with a ſecond-hand, would be moſt eligible on this occaſion, and it ſhould be hung to your quadrant in ſuch a poſition, that the inſtant you take your altitude, you ſhould perceive the moment of time.

I then (*q*) found that at the meridian of Greenwich, in the ſame latitude of 20° 48′ ſouth, the moon's true central altitude was (*r*) 33° 24′, which being directly 6° 00½′ leſs than the altitude at the ſhip, ſhews that the longitude by account was correct.

| | | |
|---|---|---|
| (q) | h. ′ | |
| Long. 172° 00′ E. ap. time of obſ. by the ſun 11 h. 28′ A.M. of 1ſt day, or | 23 28 | |
| For 172° 00′ E. deduct | 11 28 | |
| Time at Greenwich | 12 00 | P.M. the 31ſt Aug. |
| Moon's decl. at 12 h. 00′ P.M. of the 31ſt of Aug. 9° 29′ S. | | Pol. diſt. 80° 31′ |
| | h. ′ ″ | |
| Moon's paſſage at ſame time | 2 53 15 | P.M. |
| True time add | 00 25 45 | |
| Moon's paſ. at 11 h. 28′ A.M. of the 1ſt | 3 19 00 | P.M. |
| Time of obſervation | 11 28 00 | A.M. |
| Angle of time | 3 51 00 | |

| | | |
|---|---|---|
| 3 h. 51′ 00″ converted into degrees and minutes | 57° 45′ S. Co. | 9,72722 |
| | 69 12 T. Co. lat. | 10,42037 |
| | | 10,14759 |
| | | 54 33¼ |
| | | 25 57¾ |
| | 54 33¼ S. Co. ar. | 0,23662 |
| | 25 57¾ S. Co. | 9,95379 |
| | 69 12 S. Co. lat. | 9,55034 |
| (r) | 33° 24′ anſwering to | 9,74075 |

As

As I have treated hitherto of the moon's riſing only (that is when ſhe is to the eaſtward conſiderably of her time of ſouthing) I ſhall now give ſome examples of her falling (or when ſhe is conſiderably to the weſtward of her time of ſouthing.)

## EXAMPLE V.

The 30th day of March 1770, ſailing weſt, in the latitude of 50° 20′ north, and weſt longitude, by account 90° 00′, at 15 minutes after 6 o'clock, P. M. apparent time, I obſerved the moon's true central altitude to be 43° 05½′, and that ſhe was falling, equally, at the rate of 9′ in a minute. I found likewiſe, that ſhe had paſſed over the meridian of Greenwich at 2h. 47′ P. M. and that ſhe ſhould come to that meridian again at 3h. 46′ the next day. So that proportionably by account, (the difference being (s) 59 minutes) ſhe ſhould be 14 minutes and 45 ſeconds later in paſſing the meridian at the ſhip, than at Greenwich. But by Note (l) the true time was found to be but 14 minutes and 10 ſeconds, and the true diſtance 127½′.

(s) As the Ephemeris makes no mention of ſeconds in the column of the moon's paſſage over the meridian—it is only finding her right aſcenſion to the hour and minute of both days (by the common method) which with the ſun's right aſcenſion in time, will give you the moon's true time of paſſage each day, and conſequently the time between both days, in minutes and ſeconds.

I then (*t*) found that at the meridian of Greenwich, in the ſame latitude of 50° 20′ north, the moon's true central altitude was (*u*) 40° 54′, which being 131½′ leſs than the altitude at the ſhip, inſtead of 127½′ (or 2 degrees 7 minutes and a half) ſhews that the longitude by account was incorrect, and that the ſhip was a head of the reckoning 4′, which is equal to 2° 48′, and conſequently makes the true longitude 92° 48′ weſt, (inſtead of 90° 00′.)

(*t*)

| | h. | ′ | |
|---|---|---|---|
| Long 90° 00′ W. apparent time of obſ. by the ſun | 6 | 15 | P. M. |
| For 90 00 W. add | 6 | 00 | |
| Time at Greenwich | 12 | 15 | P. M. |

Moon's declination at 12h. 15′, P. M. 20° 40′ N. } Pol. diſt. 69° 20′

| | h. | ′ | ″ | |
|---|---|---|---|---|
| Moon's paſſage at ſame time | 3 | 08 | 46 | P. M. |
| True time deduct | 00 | 14 | 10 | |
| Moon's paſſage at 6 h. 15′ | 2 | 54 | 36 | P. M. |
| Time of obſervation | 6 | 15 | 00 | P. M. |
| Angle of time | 3 | 20 | 24 | |

| | | | |
|---|---|---|---|
| 3h. 20′ 24″ converted into degrees and minutes } | 50° 06′ S. | Co. | 9,80715 |
| | 39 40 T. | Co. lat. | 9,91867 |
| | | | 9,72582 |
| | | | 28 00½ |
| | | | 41 19½ |

| | | |
|---|---|---|
| 28° 00½′ S. | Co. ar. | 0,05410 |
| 41 19½ S. | Co. | 9,87561 |
| 39 40 | S. Co. lat. | 9,88635 |

(*u*) 40° 54′ anſwering to 9,81606

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## EXAMPLE VI.

The 22d day of March 1772, sailing east, in the latitude of 27° 00′ south, and east longitude, by account 105° 00′, at 7 o'clock in the morning, apparent time, I observed the moon's true central altitude to be 24° 49′, and that she was falling, equally, at the rate of 14′ in a minute. I found that she should pass over the meridian of Greenwich (*x*) at 30 minutes after 2 o'clock the same morning, and that the next morning she should come to the same meridian at 27 minutes after 3 o'clock. So that proportionably by account (the difference being 57 minutes) she should be 16 minutes and $37\frac{1}{2}$ seconds earlier in passing the meridian at the ship, than at Greenwich. But by Note (*l*), the true time was found to be but 15 minutes and 59 seconds, and the true distance to be $213\frac{1}{2}$, (or 3° $33\frac{1}{2}$′.)

(*x*) By 30 minutes after 2 o'clock, in the morning of the 22d day of March, is to be understood 14 hours and 30 minutes of the 21st day of March; as all astronomical accounts, with respect to apparent time, begin the day at noon, and count up to 24 hours, or the succeeding noon—when the day begins again.

I then

I then *(y)* found that at the meridian of Greenwich, in the same latitude of $27^{\circ}$ $00'$ south, the moon's true central altitude was *(z)* $28^{\circ}$ $22\frac{1}{2}'$, which being precisely $3^{\circ}$ $33\frac{1}{2}'$ more than the altitude at the ship, shews that the longitude by account was perfectly right.

*(y)*

| | h. ′ ″ |
|---|---|
| Long. 105°00′E. app. time of obs. by the sun 7h. 00′A. M. of the 22d day, or | 19 00 |
| For 105°00′E. deduct | 7 00 |
| Time at Greenwich | 12 00 P. M. the 21st. |
| Moon's decl. at 12h. 00′ P. M. of the 21st day 13° 51′ S. | Pol. Dist. 76° 09′ |
| Moon's passage at same time | 14 24 18 P. M. |
| True time add | 00 15 59 |
| Moon's pas. at 7h. 00′ A. M. of the 22d day | 14 40 17 P. M. |
| Time of obs. 7h. 00′ A. M. of 22d day, or | 19 00 00 |
| Angle of time | 4 19 43 |

4h. 19′ 43″ converted into deg. and min. } 64° 55¾′ S. Co. 9,62710

63 00 T. Co. la. 10,29283

9,91993

39 45

36 24

| | | |
|---|---|---|
| 39 45 | S. Co. ar. | 6,11416 |
| 36 24 | S. Co. | 9,90572 |
| 63 00 | S. Co. lat. | 9,65704 |

*(z)* 28° 22½′ answering to 9,67692

From

From the foregoing examples, the reader may obſerve, that in clear weather, at all times nearly, and in all latitudes (while the moon is perceptible, which is twenty-four days in each month) the longitude may be readily found at ſea, with the greateſt accuracy, without having recourſe to ſtars, or nocturnal obſervations. And that even at all viſible eclipſes of the ſun, the foregoing method will hold good by obſerving the moon's (*aa*) upper or lower limb on the body of the ſun, near the middle of ſuch eclipſe, and from thence finding her true central altitude by Note (*e*).

## EXAMPLE VII.

The 25th day of July 1767, ſailing weſt, in the latitude of 17° 30′ ſouth, and weſt longitude, by account 149° 00′, at half an hour after 7 o'clock in the morning, apparent time, I obſerved the moon's true central altitude to be (*bb*) 14° 46¼′, and that ſhe was riſing, equally, at the rate of 12¾′ in a minute. I alſo found that ſhe had paſſed over the meridian of Greenwich at 23h. 45′ P. M. of the 24th day (which was 50 minutes later than the day before) and that ſhe ſhould not come to the ſame meridian the next day till oh. 31′, which is but 46 minutes later: now as the obſervation was made at ſuch time as nearly to take in equal moieties from the 50 minutes, and the 46 minutes, it leaves the true mean time at 48 minutes, from one day to the other. So that proportionably by

(*aa*) Her upper limb is to be taken when the ſun is higher; and her lower limb, when ſhe is higher than the ſun; or either when the eclipſe is central.

(*bb*) See Page 17.

account,

account, ſhe ſhould be 19′ 52″ later in paſſing the meridian at the ſhip, than at Greenwich; but by Note (*a*), and (*l*), I found the true time to be but 19′06″, and the true diſtance but 242¼′, (or 4° 02¼′).

I then (*cc*) found that at the meridian of Greenwich, in the ſame latitude of 17° 30′ ſouth, the moon's true central altitude to be (*dd*) 18° 48½′, which being exactly 4° 02¼′ more than the altitude at the ſhip, ſhews that the longitude, by account, was perfectly right.

| (cc) | ° ′ | | h. ′ |
|---|---|---|---|
| Long. | 149 00W. | apparent time of obſ. by the Sun | 7 30 A.M. |
| For | 149 00W. | add | 9 56 |
| | | Time at Greenwich | 5 26 P.M. |

Moon's decl. at 5h. 26′ P. M. of the 25th 19° 43′ N. } Pol. diſt. 109° 43′

| | h. ′ ″ |
|---|---|
| Moon's paſſage at ſame time | 23 56 26 |
| True time deduct | 00 19 06 |
| Moon's paſ. at 7h. 30′ A.M. of 25th d. | 23 37 20 |
| Time of obſ. 7h. 30′ A.M. of 25th d. or | 19 30 00 |
| Angle of time | 4 07 20 |

| | | | | |
|---|---|---|---|---|
| 4h. 07′ 20″ converted into degrees and minutes | 61° 50′ | S. Co. | 9,67398 | |
| | 72 30 | T. C. lat. | 10,50127 | |
| | | | 10,17525 | |
| | | | | 56 15½ |
| | | | | 53 27½ |
| | 56 13⅓ | S. Co. ar. | 0,25538 | |
| | 53 29⅔ | S. Co. | 9,77481 | |
| | 72 30 | S. Co. lat. | 9,47815 | |
| (da) | 18° 48½′ | anſwering to | 9,50834 | |

At

At all obſervations made of the moon, when diſtant from the meridian, I found it neceſſary to take the altitudes at equal intervals of time, divided in ſuch manner, that thoſe intervals when put together ſhould make up nearly the true time at the ſhip: for inſtance, in the laſt (*ee*) Example, the true time was found to be 19 minutes, and 6 ſeconds: now as 19′ 6″ was neareſt to 20, I took that number; ſo that the firſt altitude was taken at 20 minutes after 7 o'clock in the morning, apparent time, the ſecond at 30 minutes after 7 o'clock, and the third altitude at 40 minutes after 7 o'clock—as below (*ff*).

(*ee*) See Page 15.

(*ff*)

| July 25th 1767 A. M. apparent time. | Obſerved alt. moon's upper limb from the horizon. |
|---|---|
| h. m. s. | ° ′ |
| 7 20 00 | 12 11 |
| 7 30 00 | 14 17 |
| 7 40 00 | 16 22 |
| Mean time | Mean alt. moon's upper limb. |
| 7 30 00 | 14 $16\frac{1}{2}$ |
| Dip. $4\frac{1}{2}$′, refraction $3\frac{3}{4}$, deduct | 00 $08\frac{1}{4}$ |
| | 14 $08\frac{1}{4}$ |
| By Note (*c*), ſub ſemidiameter | 00 15 |
| | 13 $53\frac{1}{4}$ |
| Parallax in altitude add | 00 53 |
| True central altitude | 14 $46\frac{1}{4}$ |

N. B. the ſame method is to be obſerved with reſpect to apparent time, found by the ſun's altitude, taken at a proper diſtance from the meridian, but as the parallax of the ſun is ſo ſmall as 10 ſeconds, it is generally left out.

When your obſervation is made at ſome hours diſtance from noon or midnight, and that you cannot directly find the moon's declination in the Ephemeris (it being put down only for thoſe two certain times) you will find proper directions in the Ephemeris to calculate your declination to the hour and minute of ſuch obſervation with the greateſt accuracy. Among the Tables neceſſary for obſervations of this kind, I have given *(gg)* thoſe for finding the Correction of the Moon's Declination for any Hour after Noon or Midnight. The other Tables are in order following, viz. A Table (*hh*) of Refraction; Tables *(ii)* of the Moon's Parallax in Altitude; Tables *(kk)* to Convert Time into Degrees and Minutes, and the contrary; and A Table *(ll)* of the Dip of the Horizon at Sea.

*(gg)* See Page 20, 21.
*(hh)* See Page 22.
*(ii)* See Page 23, 24, 25.
*(kk)* See Page 26, 27, 28.
*(ll)* See Page 29.

T A-

# T A B L E S

Neceſſary to be Uſed with the foregoing

# E X A M P L E S.

TABLES for finding the Correction of the Moon's Declination for any Hour After Noon or Midnight.

| After Noon or Midnight. | | Second Difference. | | | | | | | | | | After Noon or Midnight. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1′ | 2′ | 3′ | 4′ | 5′ | 6′ | 7′ | 8′ | 9′ | 10′ | | |
| H. | M. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | H. | M. |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 |
| 0 | 10 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 11 | 50 |
| 0 | 20 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 11 | 40 |
| 0 | 30 | 1 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 11 | 30 |
| 0 | 40 | 2 | 4 | 5 | 7 | 8 | 9 | 11 | 13 | 14 | 16 | 11 | 20 |
| 0 | 50 | 2 | 4 | 6 | 8 | 10 | 11 | 13 | 15 | 17 | 19 | 11 | 10 |
| 1 | 0 | 2 | 5 | 7 | 9 | 11 | 14 | 16 | 18 | 21 | 23 | 11 | 0 |
| 1 | 10 | 3 | 6 | 8 | 11 | 13 | 16 | 18 | 21 | 24 | 26 | 10 | 50 |
| 1 | 20 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 23 | 27 | 30 | 10 | 40 |
| 1 | 30 | 3 | 7 | 10 | 13 | 16 | 20 | 23 | 26 | 29 | 33 | 10 | 30 |
| 1 | 40 | 4 | 7 | 11 | 14 | 18 | 22 | 25 | 29 | 32 | 36 | 10 | 20 |
| 1 | 50 | 4 | 8 | 12 | 16 | 19 | 24 | 27 | 31 | 35 | 39 | 10 | 10 |
| 2 | 0 | 4 | 8 | 12 | 17 | 21 | 25 | 29 | 33 | 37 | 42 | 10 | 0 |
| 2 | 10 | 4 | 9 | 13 | 18 | 22 | 26 | 31 | 35 | 40 | 44 | 9 | 50 |
| 2 | 20 | 5 | 9 | 14 | 19 | 23 | 28 | 33 | 38 | 42 | 47 | 9 | 40 |
| 2 | 30 | 5 | 10 | 15 | 20 | 25 | 30 | 34 | 40 | 44 | 49 | 9 | 30 |
| 2 | 40 | 5 | 10 | 15 | 21 | 26 | 31 | 36 | 42 | 47 | 52 | 9 | 20 |
| 2 | 50 | 5 | 11 | 16 | 22 | 27 | 32 | 38 | 43 | 49 | 54 | 9 | 10 |
| 3 | 0 | 6 | 11 | 17 | 23 | 28 | 34 | 39 | 45 | 51 | 56 | 9 | 0 |
| 3 | 10 | 6 | 11 | 17 | 23 | 29 | 35 | 41 | 46 | 52 | 58 | 8 | 50 |
| 3 | 20 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 8 | 40 |
| 3 | 30 | 6 | 12 | 18 | 25 | 31 | 37 | 43 | 49 | 56 | 62 | 8 | 30 |
| 3 | 40 | 6 | 12 | 19 | 25 | 32 | 38 | 45 | 51 | 58 | 63 | 8 | 20 |
| 3 | 50 | 6 | 13 | 19 | 26 | 33 | 39 | 46 | 52 | 59 | 65 | 8 | 10 |
| 4 | 0 | 7 | 13 | 20 | 27 | 33 | 40 | 47 | 53 | 60 | 67 | 8 | 0 |
| 4 | 10 | 7 | 13 | 20 | 27 | 34 | 41 | 47 | 54 | 61 | 68 | 7 | 50 |
| 4 | 20 | 7 | 14 | 21 | 28 | 35 | 4[illegible] | 48 | 55 | 62 | 69 | 7 | 40 |
| 4 | 30 | 7 | 14 | 2[illegible] | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 7 | 30 |
| 4 | 40 | 7 | 14 | 21 | 28 | 36 | 43 | 50 | 57 | 64 | 71 | 7 | 20 |
| 4 | 50 | 7 | 14 | 22 | 29 | 36 | 44 | 51 | 58 | 65 | 72 | 7 | 10 |
| 5 | 0 | 7 | 14 | 2[illegible] | 29 | 36 | 44 | 5[illegible] | 59 | 66 | 73 | 7 | 0 |
| 5 | 30 | 7 | 15 | 22 | 30 | 37 | 45 | 52 | 60 | 67 | 74 | 6 | 30 |
| 6 | 0 | 8 | 15 | 23 | 30 | 38 | 46 | 53 | 60 | 68 | 75 | 6 | 0 |

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TABLES for finding the Correction of the Moon's Declination for any Hour After Noon or Midnight.

| After Noon or Midnight | | Second Difference. | | | | | | | | | | After Noon or Midnignt | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 11′ | 12′ | 13′ | 14′ | 15′ | 16′ | 17′ | 18′ | 19′ | 20′ | | |
| H. | M. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | H. | M. |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 |
| 0 | 10 | 5 | 5 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 11 | 50 |
| 0 | 20 | 9 | 9 | 10 | 11 | 12 | 12 | 13 | 14 | 14 | 16 | 11 | 40 |
| 0 | 30 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 21 | 23 | 24 | 11 | 30 |
| 0 | 40 | 17 | 18 | 20 | 22 | 23 | 25 | 27 | 28 | 30 | 31 | 11 | 20 |
| 0 | 50 | 21 | 22 | 25 | 26 | 28 | 30 | 33 | 35 | 36 | 38 | 11 | 10 |
| 1 | 0 | 25 | 27 | 30 | 32 | 34 | 36 | 39 | 40 | 42 | 45 | 11 | 0 |
| 1 | 10 | 29 | 32 | 35 | 37 | 40 | 42 | 44 | 46 | 48 | 52 | 10 | 50 |
| 1 | 20 | 32 | 35 | 38 | 41 | 44 | 47 | 49 | 52 | 55 | 59 | 10 | 40 |
| 1 | 30 | 36 | 39 | 42 | 45 | 49 | 52 | 55 | 59 | 62 | 65 | 10 | 30 |
| 1 | 40 | 39 | 43 | 46 | 50 | 53 | 57 | 61 | 64 | 68 | 72 | 10 | 20 |
| 1 | 50 | 42 | 46 | 49 | 54 | 58 | 62 | 66 | 69 | 73 | 77 | 10 | 10 |
| 2 | 0 | 45 | 50 | 54 | 58 | 62 | 67 | 71 | 75 | 79 | 83 | 10 | 0 |
| 2 | 10 | 48 | 53 | 57 | 62 | 66 | 71 | 75 | 80 | 84 | 89 | 9 | 50 |
| 2 | 20 | 51 | 56 | 61 | 66 | 70 | 75 | 80 | 85 | 89 | 94 | 9 | 40 |
| 2 | 30 | 54 | 59 | 64 | 69 | 74 | 79 | 84 | 89 | 94 | 99 | 9 | 30 |
| 2 | 40 | 57 | 62 | 67 | 72 | 78 | 83 | 88 | 93 | 98 | 103 | 9 | 20 |
| 2 | 50 | 59 | 64 | 70 | 75 | 81 | 87 | 92 | 97 | 102 | 108 | 9 | 10 |
| 3 | 0 | 61 | 67 | 73 | 78 | 84 | 90 | 96 | 101 | 106 | 112 | 9 | 0 |
| 3 | 10 | 64 | 70 | 75 | 81 | 87 | 93 | 99 | 104 | 110 | 117 | 8 | 50 |
| 3 | 20 | 66 | 72 | 78 | 83 | 90 | 96 | 102 | 108 | 114 | 121 | 8 | 40 |
| 3 | 30 | 68 | 74 | 80 | 87 | 93 | 99 | 105 | 111 | 118 | 124 | 8 | 30 |
| 3 | 40 | 70 | 76 | 82 | 89 | 95 | 102 | 108 | 115 | 121 | 127 | 8 | 20 |
| 3 | 50 | 71 | 78 | 84 | 91 | 97 | 104 | 110 | 118 | 124 | 130 | 8 | 10 |
| 4 | 0 | 73 | 80 | 86 | 93 | 100 | 107 | 113 | 120 | 127 | 133 | 8 | 0 |
| 4 | 10 | 75 | 82 | 88 | 95 | 102 | 109 | 115 | 122 | 129 | 136 | 7 | 50 |
| 4 | 20 | 76 | 83 | 90 | 97 | 103 | 110 | 117 | 124 | 131 | 138 | 7 | 40 |
| 4 | 30 | 77 | 84 | 91 | 98 | 105 | 112 | 119 | 126 | 133 | 140 | 7 | 30 |
| 4 | 40 | 78 | 85 | 92 | 99 | 106 | 113 | 120 | 128 | 135 | 142 | 7 | 20 |
| 4 | 50 | 79 | 86 | 93 | 101 | 107 | 115 | 122 | 120 | 137 | 144 | 7 | 10 |
| 5 | 0 | 80 | 87 | 94 | 102 | 109 | 117 | 124 | 131 | 139 | 146 | 7 | 0 |
| 5 | 30 | 82 | 89 | 96 | 104 | 111 | 119 | 126 | 134 | 142 | 148 | 6 | 30 |
| 6 | 0 | 83 | 91 | 97 | 105 | 112 | 120 | 127 | 135 | 143 | 150 | 6 | 0 |

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## A TABLE of Refraction.

| Alt. | Ref. | Alt. | Ref. | Alt. | Ref. | Alt. | Ref. | Alt. | Ref. |
|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ |
| 0 0 | 33 0 | 4 50 | 10 12 | 10 30 | 5 0 | 26 0 | 1 55 | 59 0 | 0 34 |
| 5 | 32 10 | 5 0 | 9 54 | 10 45 | 4 53 | 27 | 1 51 | 60 | 33 |
| 10 | 31 22 | 5 10 | 9 38 | 11 0 | 4 47 | 28 | 1 47 | 61 | 32 |
| 15 | 30 36 | 5 20 | 9 24 | 11 15 | 4 40 | 29 | 1 42 | 62 | 30 |
| 20 | 29 50 | 5 30 | 9 9 | 11 30 | 4 35 | 30 | 1 38 | 63 | 29 |
| 30 | 28 23 | 5 40 | 8 54 | 11 45 | 4 29 | 31 | 1 35 | 64 | 28 |
| 32 | 28 5 | 5 50 | 8 41 | 12 0 | 4 23 | 32 | 1 31 | 65 | 26 |
| 36 | 27 30 | 6 0 | 8 28 | 12 20 | 4 16 | 33 | 1 28 | 66 | 25 |
| 40 | 26 59 | 6 10 | 8 15 | 12 40 | 4 9 | 34 | 1 24 | 67 | 24 |
| 50 | 25 42 | 6 20 | 8 3 | 13 0 | 4 3 | 35 | 1 21 | 68 | 23 |
| 1 0 | 24 29 | 6 30 | 7 51 | 13 20 | 3 57 | 36 | 1 18 | 69 | 22 |
| 1 10 | 23 19 | 6 40 | 7 40 | 13 40 | 3 51 | 37 | 1 15 | 70 | 21 |
| 1 20 | 22 15 | 6 50 | 7 30 | 14 0 | 3 45 | 38 | 1 13 | 71 | 19 |
| 1 30 | 21 14 | 7 0 | 7 20 | 14 20 | 3 40 | 39 | 1 10 | 72 | 18 |
| 1 40 | 20 18 | 7 10 | 7 11 | 14 40 | 3 35 | 40 | 1 8 | 73 | 17 |
| 1 50 | 19 25 | 7 20 | 7 2 | 15 0 | 3 29 | 41 | 1 6 | 74 | 16 |
| 2 0 | 18 35 | 7 30 | 6 54 | 15 30 | 3 24 | 42 | 1 3 | 75 | 15 |
| 2 10 | 17 48 | 7 40 | 6 45 | 16 0 | 3 17 | 43 | 1 1 | 76 | 14 |
| 2 20 | 17 4 | 7 50 | 6 37 | 16 30 | 3 10 | 44 | 59 | 77 | 13 |
| 2 30 | 16 24 | 8 0 | 6 29 | 17 0 | 3 5 | 45 | 57 | 78 | 12 |
| 2 40 | 15 46 | 8 10 | 6 22 | 17 30 | 2 59 | 46 | 55 | 79 | 11 |
| 2 50 | 15 9 | 8 20 | 6 15 | 18 0 | 2 54 | 47 | 53 | 80 | 10 |
| 3 0 | 14 36 | 8 30 | 6 8 | 18 30 | 2 49 | 48 | 51 | 81 | 9 |
| 3 10 | 14 4 | 8 40 | 6 1 | 19 0 | 2 44 | 49 | 49 | 82 | 8 |
| 3 20 | 13 34 | 8 50 | 5 55 | 19 30 | 2 39 | 50 | 47 | 83 | 7 |
| 3 30 | 13 6 | 9 0 | 5 48 | 20 0 | 2 35 | 51 | 46 | 84 | 6 |
| 3 40 | 12 40 | 9 10 | 5 42 | 20 30 | 2 31 | 52 | 44 | 85 | 5 |
| 3 50 | 12 14 | 9 20 | 5 36 | 21 0 | 2 27 | 53 | 43 | 86 | 4 |
| 4 0 | 11 51 | 9 30 | 5 31 | 21 30 | 2 24 | 54 | 41 | 87 | 3 |
| 4 10 | 11 29 | 9 40 | 5 25 | 22 0 | 2 20 | 55 | 39 | 88 | 2 |
| 4 20 | 11 8 | 9 50 | 5 20 | 23 0 | 2 14 | 56 | 38 | 89 | 1 |
| 4 30 | 10 48 | 10 0 | 5 15 | 24 0 | 2 7 | 57 | 37 | 90 | 0 |
| 4 40 | 10 30 | 10 15 | 5 8 | 25 0 | 2 1 | 58 | 36 | | |

## TABLES of the Moon's Parallax in Altitude.

| Moon's Alt. | Moon's Hoizontal Parallax. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ° | ′ 54 | ′ 55 | ′ 56 | ′ 57 | ′ 58 | ′ 59 | ′ 60 | ′ 61 | ′ 62 |
| 1 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 2 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 3 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 4 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 5 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 6 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 7 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| 8 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |
| 9 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |
| 10 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |
| 11 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |
| 12 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |
| 13 | 53 | 54 | 55 | 55 | 56 | 57 | 58 | 59 | 60 |
| 14 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 15 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 16 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 58 | 59 |
| 17 | 52 | 53 | 54 | 54 | 55 | 56 | 57 | 58 | 59 |
| 18 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |
| 19 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |
| 20 | 51 | 52 | 53 | 54 | 54 | 55 | 56 | 57 | 58 |
| 21 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 |
| 22 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 57 |
| 23 | 50 | 51 | 51 | 52 | 53 | 54 | 55 | 56 | 57 |
| 24 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 |
| 25 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 | 56 |
| 26 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
| 27 | 48 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 |
| 28 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 54 | 55 |
| 29 | 47 | 48 | 49 | 50 | 51 | 52 | 52 | 53 | 54 |
| 30 | 47 | 48 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |

## TABLES of the Moon's Parallax in Altitude.

| Moon's Alt. | Moon's Horiz. Parallax. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ° | ′ 54 | ′ 55 | ′ 56 | ′ 57 | ′ 58 | ′ 59 | ′ 60 | ′ 61 | ′ 62 |
| 31 | 46 | 47 | 48 | 49 | 50 | 51 | 51 | 52 | 53 |
| 32 | 46 | 47 | 47 | 48 | 49 | 50 | 51 | 52 | 53 |
| 33 | 45 | 46 | 47 | 48 | 49 | 49 | 50 | 51 | 52 |
| 34 | 45 | 46 | 46 | 47 | 48 | 49 | 50 | 51 | 52 |
| 35 | 44 | 45 | 46 | 47 | 47 | 48 | 49 | 50 | 51 |
| 36 | 44 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 50 |
| 37 | 43 | 44 | 45 | 45 | 46 | 47 | 48 | 49 | 50 |
| 38 | 43 | 43 | 44 | 45 | 46 | 46 | 47 | 48 | 49 |
| 39 | 42 | 43 | 43 | 44 | 45 | 46 | 47 | 47 | 48 |
| 40 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 48 |
| 41 | 41 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 |
| 42 | 40 | 41 | 42 | 42 | 43 | 44 | 45 | 45 | 46 |
| 43 | 39 | 40 | 41 | 42 | 42 | 43 | 44 | 45 | 46 |
| 44 | 39 | 40 | 40 | 41 | 42 | 42 | 43 | 44 | 45 |
| 45 | 38 | 39 | 40 | 40 | 41 | 42 | 43 | 43 | 44 |
| 46 | 37 | 38 | 39 | 40 | 40 | 41 | 42 | 42 | 43 |
| 47 | 37 | 38 | 38 | 39 | 40 | 40 | 41 | 42 | 43 |
| 48 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 42 |
| 49 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 |
| 50 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 |
| 51 | 34 | 35 | 35 | 36 | 36 | 37 | 38 | 38 | 39 |
| 52 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 38 | 39 |
| 53 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 38 |
| 54 | 32 | 32 | 33 | 33 | 34 | 35 | 35 | 36 | 37 |
| 55 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 35 | 36 |
| 56 | 30 | 31 | 31 | 32 | 32 | 33 | 34 | 34 | 35 |
| 57 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 33 | 34 |
| 58 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 |
| 59 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 |
| 60 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 30 |

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## TABLES of the Moon's Parallax in Altitude.

| Moon's Alt. | Moon's Horiz. Parallax. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ° | ′ 54 | ′ 55 | ′ 56 | ′ 57 | ′ 58 | ′ 59 | ′ 60 | ′ 61 | ′ 62 |
| 61 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 |
| 62 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 |
| 63 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 |
| 64 | 24 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 |
| 65 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 26 | 26 |
| 66 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 25 |
| 67 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 24 |
| 68 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 | 23 |
| 69 | 19 | 20 | 20 | 20 | 21 | 21 | 21 | 22 | 22 |
| 70 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | 21 |
| 71 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 20 | 20 |
| 72 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 19 | 19 |
| 73 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | 18 |
| 74 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 17 |
| 75 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 |
| 76 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 15 | 15 |
| 77 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 14 | 14 |
| 78 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 13 | 13 |
| 79 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 |
| 80 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 |
| 81 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 |
| 82 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 |
| 83 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 |
| 84 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 |
| 85 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 86 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 87 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 88 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 89 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## TABLES to convert Time into Degrees and Minutes, and the contrary.

| D | H. | M. | D | H. | M. | D | H. | M. | D. | H. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 4 | 31 | 2 | 4 | 61 | 4 | 4 | 91 | 6 | 4 |
| 2 | 0 | 8 | 32 | 2 | 8 | 62 | 4 | 8 | 92 | 6 | 8 |
| 3 | 0 | 12 | 33 | 2 | 12 | 63 | 4 | 12 | 93 | 6 | 12 |
| 4 | 0 | 16 | 34 | 2 | 16 | 64 | 4 | 16 | 94 | 6 | 16 |
| 5 | 0 | 20 | 35 | 2 | 20 | 65 | 4 | 20 | 95 | 6 | 20 |
| 6 | 0 | 24 | 36 | 2 | 24 | 66 | 4 | 24 | 96 | 6 | 24 |
| 7 | 0 | 28 | 37 | 2 | 28 | 67 | 4 | 28 | 97 | 6 | 28 |
| 8 | 0 | 32 | 38 | 2 | 32 | 68 | 4 | 32 | 98 | 6 | 32 |
| 9 | 0 | 36 | 39 | 2 | 36 | 69 | 4 | 36 | 99 | 6 | 36 |
| 10 | 0 | 40 | 40 | 2 | 40 | 70 | 4 | 40 | 100 | 6 | 40 |
| 11 | 0 | 44 | 41 | 2 | 44 | 71 | 4 | 44 | 101 | 6 | 44 |
| 12 | 0 | 48 | 42 | 2 | 48 | 72 | 4 | 48 | 102 | 6 | 48 |
| 13 | 0 | 52 | 43 | 2 | 52 | 73 | 4 | 52 | 103 | 6 | 52 |
| 14 | 0 | 56 | 44 | 2 | 56 | 74 | 4 | 56 | 104 | 6 | 56 |
| 15 | 1 | 0 | 45 | 3 | 0 | 75 | 5 | 0 | 105 | 7 | 0 |
| 16 | 1 | 4 | 46 | 3 | 4 | 76 | 5 | 4 | 106 | 7 | 4 |
| 17 | 1 | 8 | 47 | 3 | 8 | 77 | 5 | 8 | 107 | 7 | 8 |
| 18 | 1 | 12 | 48 | 3 | 12 | 78 | 5 | 12 | 108 | 7 | 12 |
| 19 | 1 | 16 | 49 | 3 | 16 | 79 | 5 | 16 | 109 | 7 | 16 |
| 20 | 1 | 20 | 50 | 3 | 20 | 80 | 5 | 20 | 110 | 7 | 20 |
| 21 | 1 | 24 | 51 | 3 | 24 | 81 | 5 | 24 | 111 | 7 | 24 |
| 22 | 1 | 28 | 52 | 3 | 28 | 82 | 5 | 28 | 112 | 7 | 28 |
| 23 | 1 | 32 | 53 | 3 | 32 | 83 | 5 | 32 | 113 | 7 | 32 |
| 24 | 1 | 36 | 54 | 3 | 36 | 84 | 5 | 36 | 114 | 7 | 36 |
| 25 | 1 | 40 | 55 | 3 | 40 | 85 | 5 | 40 | 115 | 7 | 40 |
| 26 | 1 | 44 | 56 | 3 | 44 | 86 | 5 | 44 | 116 | 7 | 44 |
| 27 | 1 | 48 | 57 | 3 | 48 | 87 | 5 | 48 | 117 | 7 | 48 |
| 28 | 1 | 52 | 58 | 3 | 52 | 88 | 5 | 52 | 118 | 7 | 52 |
| 29 | 1 | 56 | 59 | 3 | 56 | 89 | 5 | 56 | 119 | 7 | 56 |
| 30 | 2 | 0 | 60 | 4 | 0 | 90 | 6 | 0 | 120 | 8 | 0 |

TABLES to convert Time into Degrees and Minutes, and the contrary.

| D. | H. | M. | D. | H. | M. | D. | H. | M. | D. | H. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 121 | 8 | 4 | 151 | 10 | 4 | 181 | 12 | 4 | 211 | 14 | 4 |
| 122 | 8 | 8 | 152 | 10 | 8 | 182 | 12 | 8 | 212 | 14 | 8 |
| 123 | 8 | 12 | 153 | 10 | 12 | 183 | 12 | 12 | 213 | 14 | 12 |
| 124 | 8 | 16 | 154 | 10 | 16 | 184 | 12 | 16 | 214 | 14 | 16 |
| 125 | 8 | 20 | 155 | 10 | 20 | 185 | 12 | 20 | 215 | 14 | 20 |
| 126 | 8 | 24 | 156 | 10 | 24 | 186 | 12 | 24 | 216 | 14 | 24 |
| 127 | 8 | 28 | 157 | 10 | 28 | 187 | 12 | 28 | 217 | 14 | 28 |
| 128 | 8 | 32 | 158 | 10 | 32 | 188 | 12 | 32 | 218 | 14 | 32 |
| 129 | 8 | 36 | 159 | 10 | 36 | 189 | 12 | 36 | 219 | 14 | 36 |
| 130 | 8 | 40 | 160 | 10 | 40 | 190 | 12 | 40 | 220 | 14 | 40 |
| 131 | 8 | 44 | 161 | 10 | 44 | 191 | 12 | 44 | 221 | 14 | 44 |
| 132 | 8 | 48 | 162 | 10 | 48 | 192 | 12 | 48 | 222 | 14 | 48 |
| 133 | 8 | 52 | 163 | 10 | 52 | 193 | 12 | 52 | 223 | 14 | 52 |
| 134 | 8 | 56 | 164 | 10 | 56 | 194 | 12 | 56 | 224 | 14 | 56 |
| 135 | 9 | 0 | 165 | 11 | 0 | 195 | 13 | 0 | 225 | 15 | 0 |
| 136 | 9 | 4 | 166 | 11 | 4 | 196 | 13 | 4 | 226 | 15 | 4 |
| 137 | 9 | 8 | 167 | 11 | 8 | 197 | 13 | 8 | 227 | 15 | 8 |
| 138 | 9 | 12 | 168 | 11 | 12 | 198 | 13 | 12 | 228 | 15 | 12 |
| 139 | 9 | 16 | 169 | 11 | 16 | 199 | 13 | 16 | 229 | 15 | 16 |
| 140 | 9 | 20 | 170 | 11 | 20 | 200 | 13 | 20 | 230 | 15 | 20 |
| 141 | 9 | 24 | 171 | 11 | 24 | 201 | 13 | 24 | 231 | 15 | 24 |
| 142 | 9 | 28 | 172 | 11 | 28 | 202 | 13 | 28 | 232 | 15 | 28 |
| 143 | 9 | 32 | 173 | 11 | 32 | 203 | 13 | 32 | 233 | 15 | 32 |
| 144 | 9 | 36 | 174 | 11 | 36 | 204 | 13 | 36 | 234 | 15 | 36 |
| 145 | 9 | 40 | 175 | 11 | 40 | 205 | 13 | 40 | 235 | 15 | 40 |
| 146 | 9 | 44 | 176 | 11 | 44 | 206 | 13 | 44 | 236 | 15 | 44 |
| 147 | 9 | 48 | 177 | 11 | 48 | 207 | 13 | 48 | 237 | 15 | 48 |
| 148 | 9 | 52 | 178 | 11 | 52 | 208 | 13 | 52 | 238 | 15 | 52 |
| 149 | 9 | 56 | 179 | 11 | 56 | 209 | 13 | 56 | 239 | 15 | 56 |
| 150 | 10 | 0 | 180 | 12 | 0 | 210 | 14 | 0 | 240 | 16 | 0 |

TABLES to convert Time into Degrees and Minutes, and the contrary.

| D. | H. | M. | D. | H. | M. | D. | H. | M. | D. | H. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 241 | 16 | 4 | 271 | 18 | 4 | 301 | 20 | 4 | 331 | 22 | 4 |
| 242 | 16 | 8 | 272 | 18 | 8 | 302 | 20 | 8 | 332 | 22 | 8 |
| 243 | 16 | 12 | 273 | 18 | 12 | 303 | 20 | 12 | 333 | 22 | 12 |
| 244 | 16 | 16 | 274 | 18 | 16 | 304 | 20 | 16 | 334 | 22 | 16 |
| 245 | 16 | 20 | 275 | 18 | 20 | 305 | 20 | 20 | 335 | 22 | 20 |
| 246 | 16 | 24 | 276 | 18 | 24 | 306 | 20 | 24 | 336 | 22 | 24 |
| 247 | 16 | 28 | 277 | 18 | 28 | 307 | 20 | 28 | 337 | 22 | 28 |
| 248 | 16 | 32 | 278 | 18 | 32 | 308 | 20 | 32 | 338 | 22 | 32 |
| 249 | 16 | 36 | 279 | 18 | 36 | 309 | 20 | 36 | 339 | 22 | 36 |
| 250 | 16 | 40 | 280 | 18 | 40 | 310 | 20 | 40 | 340 | 22 | 40 |
| 251 | 16 | 44 | 281 | 18 | 44 | 311 | 20 | 44 | 341 | 22 | 44 |
| 252 | 16 | 48 | 282 | 18 | 48 | 312 | 20 | 48 | 342 | 22 | 48 |
| 253 | 16 | 52 | 283 | 18 | 52 | 313 | 20 | 52 | 343 | 22 | 52 |
| 254 | 16 | 56 | 284 | 18 | 56 | 314 | 20 | 56 | 344 | 22 | 56 |
| 255 | 17 | 0 | 285 | 19 | 0 | 315 | 21 | 0 | 345 | 23 | 0 |
| 256 | 17 | 4 | 286 | 19 | 4 | 316 | 21 | 4 | 346 | 23 | 4 |
| 257 | 17 | 8 | 287 | 19 | 8 | 317 | 21 | 8 | 347 | 23 | 8 |
| 258 | 17 | 12 | 288 | 19 | 12 | 318 | 21 | 12 | 348 | 23 | 12 |
| 259 | 17 | 16 | 289 | 19 | 16 | 319 | 21 | 16 | 349 | 23 | 16 |
| 260 | 17 | 20 | 290 | 19 | 20 | 320 | 21 | 20 | 350 | 23 | 20 |
| 261 | 17 | 24 | 291 | 19 | 24 | 321 | 21 | 24 | 351 | 23 | 24 |
| 262 | 17 | 28 | 292 | 19 | 28 | 322 | 21 | 28 | 352 | 23 | 28 |
| 263 | 17 | 32 | 293 | 19 | 32 | 323 | 21 | 32 | 353 | 23 | 32 |
| 264 | 17 | 36 | 294 | 19 | 36 | 324 | 21 | 36 | 354 | 23 | 36 |
| 265 | 17 | 40 | 295 | 19 | 40 | 325 | 21 | 40 | 355 | 23 | 40 |
| 266 | 17 | 44 | 296 | 19 | 44 | 326 | 21 | 44 | 356 | 23 | 44 |
| 267 | 17 | 48 | 297 | 19 | 48 | 327 | 21 | 48 | 357 | 23 | 48 |
| 268 | 17 | 52 | 298 | 19 | 52 | 328 | 21 | 52 | 358 | 23 | 52 |
| 269 | 17 | 56 | 299 | 19 | 56 | 329 | 21 | 56 | 359 | 23 | 56 |
| 270 | 18 | 0 | 300 | 20 | 0 | 330 | 22 | 0 | 360 | 24 | 0 |

## A TABLE of the Dip of the Horizon at Sea.

| Height of the Eye above the Sea. | Dip of the Sea. | |
|---|---|---|
| Feet. | ′ | ″ |
| 1 | 0 | 55 |
| 2 | 1 | 10 |
| 3 | 1 | 35 |
| 4 | 1 | 50 |
| 5 | 2 | 5 |
| 6 | 2 | 18 |
| 7 | 2 | 29 |
| 8 | 2 | 40 |
| 9 | 2 | 50 |
| 10 | 3 | 0 |
| 12 | 3 | 15 |
| 14 | 3 | 30 |
| 16 | 3 | 45 |
| 18 | 4 | 0 |
| 20 | 4 | 15 |
| 22 | 4 | 30 |
| 24 | 4 | 45 |
| 26 | 4 | 55 |
| 28 | 5 | 5 |
| 30 | 5 | 15 |
| 35 | 5 | 45 |
| 40 | 6 | 9 |
| 45 | 6 | 30 |
| 50 | 6 | 48 |
| 60 | 7 | 36 |
| 70 | 8 | 0 |
| 80 | 8 | 30 |
| 90 | 9 | 0 |
| 100 | 9 | 30 |
| 110 | 10 | 0 |

The

The foregoing Tables, with the Ephemeris, and a correct Table of Logarithmic Sines and Tangents, are all that are necessary for finding the Longitude at Sea.—But the observator should be particularly careful of his proportion and accuracy in the last mentioned Table, as a very small mistake *there*, might make a sensible difference with respect to the truth of his observation. I would therefore recommend to him (as a proof of his work) to try whether the altitude taken by the moon, would give the same latitude precisely at the meridian of Greenwich, as that taken by the sun: if not, there is certainly a mistake in the work, and he should carefully look over it again, till he exactly made it agree with that latitude obtained by observation of the sun. Nay, the altitude at the ship, should give the same latitude as that at the meridian of Greenwich, and both correspond respectively with each other. For (*a*) instance, in

(*a*) See Page 3, and 4.

EXAM-

## EXAMPLE I.

The 10th (*b*) day of July 1767, at six o'clock in the afternoon, apparent time, in the latitude of 47° 15′ south, the moon's true central altitude was found to be 27° 01′ at the meridian of Greenwich; and her true central altitude at the ship 24° 37′; the angle of time was 5h. 6′ 12″ at the former, and at the latter 5h. 20′ 36″, with 25° 05′ south declination.—Then,

### At Greenwich.

| | | | | |
|---|---|---|---|---|
| The ang. of time which is 5h. 6′ 12″ conv. into deg. and min. | 76° 33′ S. | Co. | 9,36660 | |
| Moon's declin. S. | 25 05 | Co. tan. | 10,32967 | |
| | | Co. tan. | 9,69627 | 63° 35′ |
| Moon's declinat. S. | 25 05 S. | Co. ar. | 0,37270 | |
| Moon's true cent. altitude. | 27 01 S. | | 9,65732 | |
| Co. tang. | 63 35 S. | | 9,95209 | |
| | | S. Co. | 9,98211 | 16 20 |
| | | | | 47 15 true lat. |

### At the ship.

| | | | | |
|---|---|---|---|---|
| 5h. 20′ 36″ angle of time conv. into deg. and minutes. | 80 09 S. | Co. | 9,23318 | |
| Moon's declinat. S. | 25 05 | Co. tan. | 10,32967 | |
| | | Co. tan. | 9,56285 | 69 55 |
| Moon's declinat. S. | 25 05 S. | Co. ar. | 0,37270 | |
| Moon's true cent. altitude. | 24 37 S. | | 9,61965 | |
| Co. tang. | 69 55 S. | | 9,97274 | |
| | | S. Co. | 9,96509 | 22 40 |
| | | | | 47 15 true lat. |

(*b*) See page 3, and 4.

When you find your longitude at the ſhip, by account, to be incorrect—In order to obtain your latitude, by the moon's true central altitude, you muſt increaſe, or diminiſh, the angle of time at the ſhip accordingly, viz. if your reckoning is a-head of the ſhip it muſt be diminiſhed: if the ſhip is a-head of the reckoning it muſt be increaſed proportionably—For inſtance, in the (c) ſecond Example, the reckoning was found to be 3 degrees and 20 minutes a-head of the ſhip, which is equal to 30 ſeconds, which 30″ taken from 3h. 15′ 34″, (the angle of time, by account, at the ſhip, when the obſervation was made) will leave it at 3h. 15′ 04″; and the true time by account, 11′ 10″, being diminiſhed in the like manner, will leave the *real* true time at (*d*) 10′ 40″.

(c) See Page 5, and 6. (d) See Page 32.

EXAM-

## EXAMPLE II.

The 6th (*e*) day of March 1767, at 2 o'clock in the afternoon, apparent time, in the latitude of $37^{\circ}\ 00'$ north, the moon's true central altitude was found to be $49^{\circ}\ 43\frac{1}{2}'$ at the meridian of Greenwich; and her true central altitude at the ship $47^{\circ}\ 35\frac{1}{2}'$; the angle of time was 3h. 4m. 24″ at the former, and at the latter 3h. 15m. 34″, with $26^{\circ}\ 16'$ north declination.—Then,

At Greenwich.

| h. ′ ″ | | ° ′ | | | |
|---|---|---|---|---|---|
| 3 04 24 | Angle of time converted into deg. and min. | 46 06 | S. Co. | 9,84098 | |
| | Moon's decl. N. | 26 16 | Co. ta. | 10,30670 | |
| | | | Co. ta. | 10,14768 | 35 26⅓ |
| | Moon's decl. N. | 26 16 | S. Co. ar. | 0,35405 | |
| | ☽'s true cent. altitude | 49 43½ | S. | 9,88248 | |
| | Co. tang. | 35 26⅓ | | 9,76330½ | |
| | | | S. Co. | 9,99983½ | 1 33⅔ |
| 0 11 10 | | | | | |
| 0 30 ded. | | | | true latitude | 37 00 |
| 0 10 40 | | | | | |

At the ship.

| | | | | | |
|---|---|---|---|---|---|
| 3 15 04 (*f*) | Angle of time converted into deg. and min. | 48 46 | S. Co. ar. | 9,81896 | |
| | Moon's decl. N. | 26 16 | Co. ta. | 10,30670 | |
| | | | Co. ta. | 10,12566 | 36 49½ |
| | Moon's decl. N. | 26 16 | S. Co. ar. | 0,35405 | |
| | ☽'s true cent. altitude | 47 35½ | S. | 9,86826 | |
| | Co. tang. | 36 49½ | S. | 9,77768 | |
| | | | S. Co. | 9,99999 | 0 11½ |
| | | | | true latitude | 37 00 |

(*e*) See Page 5, and 6. (*f*) See Page 32.



When

When your operation either at the ſhip, or at Greenwich, or both, turns out in ſuch manner, that your laſt ſine complement (in the Tables of Sines and Tangents) anſwers to figures all like one another, ſuch as (*g*) 9,99999, (as in the laſt Example); or any other figures, that are annexed to more than one number, ſuch as 9,99998, which laſt figures are annexed to eleven different numbers in that Table—then, in ſuch caſe, you ſhould take the middlemoſt of theſe numbers, or the half of eleven, which is five and a half.—So with 9,99999, which laſt figures, are annexed to twenty-three different numbers, in the beginning of that Table, the half will be found to be eleven and a half.—But an Example of this kind ſeldom happens.

(*g*) See page 33.

EXAM-

### EXAMPLE III.

The 16th *(b)* day of July 1768, at 5 o'clock in the morning, appparent time, in the latitude of 46° 52′ north, the moon's true central altitude was found to be 43° 24′ at the meridian of Greenwich, . and her true central altitude at the ſhip 45° 24′; the angle of time was 3h. 20′ 38″ at the former, and at the latter 3h. 8′ 38″, with 22° 25′ north declination.—Then,

At Greenwich.

| | ° ′ | | | ° ′ |
|---|---|---|---|---|
| The ang. of time which is 3h. 20′ 38″ conv. into deg. and min. | 50 09½ | S. Co. | 9,80662 | |
| Moon's declin. N. | 22 52 | Co. tan. | 10,37496 | |
| | | Co. tan. | 10,18158 | 33 21½ |
| Moon's declin. N. | 22 52 | S. Co. ar. | 0,41053 | |
| Moon's true cent. altitude. | 43 24 | S. | 9,83702 | |
| Co. tang. | 33 21½ | S. | 9,74026 | |
| | | S. Co. | 9,98781 | 13 30½ |
| | | | | 46 52 true la. |

At the ſhip.

| | | | | |
|---|---|---|---|---|
| 3h. 8′ 38″ angle of time conv. into degr. and minutes | 47 09½ | S. Co. | 9,83250 | |
| Moon's declinat. N. | 22 52 | Co. tan. | 10,37496 | |
| | | Co. tan. | 10,20746 | 31 48½ |
| Moon's declin. N. | 22 52 | S. Co. ar. | 0,41053 | |
| Moon's true cent. altitude | 45 24 | S. | 9,85248 | |
| Co. tang. | 31 48½ | S. | 9,72180 | |
| | | S. Co. | 9,98481 | 15 03½ |
| | | | | 46 52 true la. |

*(b)* See page 7, and 8.

When your obſervation of the moon is taken at, or near the break, or *(i)* cloſe of day, which will ſometimes happen (as in the firſt Example), and the ſun conſequently below the horizon, you muſt depend, ſome ſmall time, upon your watch going right, for the truth of your apparent time. —(And, it would be a very bad watch indeed, that would not keep equal time for the ſpace of two or three hours.)

When your obſervation is taken at, or near noon, and the ſun conſequently at, or near the meridian, which will ſometimes happen, (as in the (*k*) fourth Example) you muſt likewiſe depend, ſome ſmall time, upon your watch going right, for the truth of your apparent time; except the ſun is in, or near the zenith.

*(i)* See page 3. *(k)* See page 9.

EXAM-

## EXAMPLE IV.

The 1st (*l*) day of September 1772, at 28 minutes after 11 o'clock, apparent time, A. M. in the latitude of 20° 48′ south, the moon's true central altitude was found to be 33° 24′ at the meridian of Greenwich; and her true central altitude at the ship 39° 24½′; the angle of time was 3h. 51′ 00″ at the former, and at the latter 3h. 25′ 15″, with 9° 29′ south declination.—Then,

**At Greenwich.**

| | ° ′ | | | ° ′ |
|---|---|---|---|---|
| The ang. of time which is 3h. 51′ 10″ conv. into deg. and min. | 57 45 | S. Co. | 9,72722 | |
| Moon's declin. S. | 9 29 | Co. tan. | 10,77717 | |
| | | Co. tan. | 10,50439 | 17 23 |
| Moon's declin. S. | 9 29 | S. Co. ar. | 0,78315 | |
| Moon's true cent. altitude. | 33 24 | S. | 9,74075 | |
| Co. tang. | 17 23 | S. | 9,47532 | |
| | | S. Co. | 9,99922 | 3 25 |
| | | | | 20 48 true l. |

**At the ship.**

| | | | | |
|---|---|---|---|---|
| 3h. 25′ 15″ angle of time conv. into degr. and minutes | 51 18¾ | S. Co. | 9,79592 | |
| Moon's declin. S. | 9 29 | Co. tan. | 10,77717 | |
| | | Co. tan. | 10,57309 | 14 57¾ |
| Moon's declin. S. | 9 29 | S. Co. ar. | 0,78315 | |
| Moon's true cent. altitude | 39 24½ | S. | 9,80266 | |
| Co. tang. | 14 57¾ | S. | 9,41193 | |
| | | S. Co. | 9,99774 | 5 50¼ |
| | | | | 20 48 true l. |

(*l*) See page 9, and 10.

When you find your longitude at the ſhip, by account, to be incorrect—in order to obtain your latitude, by the moon's true central altitude, (as has been *(m)* before obſerved) you muſt increaſe, or diminiſh, the angle of time at the ſhip accordingly; viz. if your reckoning is a-head of the ſhip it muſt be diminiſhed; as in Example the ſecond: if the ſhip is a-head of the reckoning, it muſt be increaſed proportionably—For inſtance, in the *(n)* fifth Example, the ſhip was found to be 2° 48′ a-head of the reckoning, which is equal to 27 ſeconds, which 27 ſeconds added to 14′ 10″, (the true time, by account) will make it 14′ 37″ for the *real* true time; and which 14′ 37″, taken from 3h. 20′ 24″, (the angle of time at Greenwich) will leave the *real* true angle of time at the ſhip *(o)* 3h. 5′ 47″.

*(m)* See page. 32. *(n)* See page 11, and 12.
*(o)* See page 39.

EXAM-

## EXAMPLE V.

The 30th *(p)* day of March 1770, at 15 minutes after 6 o'clock in the afternoon, apparent time, in the latitude of 50° 20′ north, the moon's true central altitude was found to be 43° 05½′ at the meridian of Greenwich, and her true central altitude at the ship 40° 54′; the angle of time was 3h. 20′ 24″ at the former, and at the latter 3h. 6′ 14″, with 20° 40′ north declination.—Then,

At Greenwich.

| h. ′ ″ | | ° ′ | | | ° ′ |
|---|---|---|---|---|---|
| 3 20 24 | Angle of time converted into deg. and min. | 50 06 | S. Co. | 9,80715 | |
| | Moon's decl. N. | 20 40 | Co. ta. | 10,42342 | |
| | | | Co. ta. | 10,23057 | 30 27½ |
| | Moon's decl. N. | 20 40 | S. Co. ar. | 0,45232 | |
| | ☽'s true cent. altitude. | 40 54 | S. | 9,81606 | |
| | Co. tang. | 30 27½ | S. | 9,70494 | |
| | | | S. Co. | 9,97332 | 19 52½ |
| 0 14 10 | | | | true latitude | 50 20 |
| 0 0 27 | add | | | | |
| 0 14 37 | | | | | |

At the ship.

| h. ′ ″ | | ° ′ | | | ° ′ |
|---|---|---|---|---|---|
| 3 05 47 | Angle of time converted into deg. and min. | 46 26¾ | S. Co. | 9,83824 | |
| | Moon's decl. N. | 20 40 | Co. ta. | 10,42342 | |
| | | | Co. ta. | 10,26166 | 28 42 |
| | Moon's decl. N. | 20 40 | S. Co. ar. | 0,45232 | |
| | ☽'s true cent. altitude | 43 05½ | S. | 9,83452 | |
| | Co. tang. | 28 42 | S. | 9,68144 | |
| | | | S. Co. | 9,96828 | 21 38 |
| | | | | true latitude | 50 20 |

*(p)* See page 11, and 12.

## EXAMPLE VI.

The 22d (*q*) day of March 1772, at 7 o'clock in the morning, apparent time, in the latitude of 27° 00′ south, the moon's true central altitude was found to be 28° 22½′ at the meridian of Greenwich; and her true central altitude at the ship 24° 49′; the angle of time was 4h. 19′ 43″ at the former, and at the latter 4h. 35′ 42″, with 13° 51′ south declination.—Then,

### At Greenwich.

| | ° ′ | | | |
|---|---|---|---|---|
| The ang of time which is 4h. 19′ 43″ conv. into deg. and min. | 64 55¾ | S. Co. | 9,62710 | |
| Moon's declin. S. | 13 51 | Co. tan. | 10,60809 | |
| | | Co. tan. | 10,23519 | 30° 11½′ |
| Moon's declin. S. | 13 51 | S. Co. ar. | 0,62092 | |
| Moon's true central altitude | 28 22½ | S. | 9,67692 | |
| Co. tang. | 30 11½ | S. | 9,70148 | |
| | | S. Co. | 9,99932 | 3 11½ |
| | | | | 27 00 true l. |

### At the ship.

| | | | | |
|---|---|---|---|---|
| 4h. 35′ 42″ ang. of time conv. into degr. and minutes | 68 55½ | S. Co. | 9,55579 | |
| Moon's declin. S. | 13 51 | Co. tan. | 10,60809 | |
| | | Co. tan. | 10,16388 | 34 26¼ |
| Moon's declin. S. | 13 51 | S. Co. ar. | 0,62092 | |
| ☽'s true central altitude | 24 49 | S. | 9,62296 | |
| Co. tang. | 34 26¼ | S. | 9,75243 | |
| | | S. Co. | 9,99631 | 7 26¼ |
| | | | | 27 00 true l. |

(*q*) See page 13, and 14.

## EXAMPLE VII.

The 25th (*r*) day of July 1767, at half an hour after 7 o'clock in the morning, apparent time, in the latitude of 17° 30′ south, the moon's true central altitude was found to be 18° 48½′ at the meridian of Greenwich; and her true central altitude at the ship 14° 46¼′; the angle of time was 4h. 07′ 20″ at the former, and at the latter 4h. 26′ 26″, with 19° 43′ north declination.—Then,

### At Greenwich.

| | | | | |
|---|---|---|---|---|
| The ang. of time which is 4h. 07′ 20″ conv. into deg. and min. | ° ′<br>61 50 | S. Co. | 9,67398 | |
| Moon's declin. N. | 19 43 | Co. tan. | 10,44566 | |
| | | Co. tan. | 10,11964 | ° ′<br>37 12⅓ |
| Moon's declin. N. | 19 43 | S. Co. ar. | 0,47191 | |
| Moon's true central altitude | 18 48½ | S. | 9,50834 | |
| Co. tang. | 37 12⅓ | S. | 9,78152 | |
| | | S. Co. | 9,76177 | 54 42⅓ |
| | | | | 17 30 true l. |

### At the ship.

| | | | | |
|---|---|---|---|---|
| 4h. 26′ 26″ ang. of time conv. into degr. and minutes | 66 36½ | S. Co. | 9,59880 | |
| Moon's declin. N. | 19 43 | Co. tan. | 10,44566 | |
| | | Co. tan. | 10,04446 | 42 04⅓ |
| Moon's declin. N. | 19 43 | S. Co. ar. | 0,47191 | |
| ☽'s true central altitude | 14 46¼ | S. | 9,40648 | |
| Co. tang. | 42 04⅓ | S. | 9,82613 | |
| | | S. Co. | 9,70452 | 59 34⅓ |
| | | | | 17 30 true l. |

(*r*) See page 15, and 16.

## E R R A T A.

P. l.

17 17 *for* 12° 11′ *read* 12° 10′.

19 *for* 16 22 *read* 16 23.

24 *for* note (*c*) *read* note (*e*).

On the next page to 29, *for* 18 *read* 30.

# CONTENTS.



FINIS.